Romancing the Drone: Military Desire and Anthropophobia from SAGE to Swarm

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ABSTRACT *This article provides an historical account of the U.S. military's creation of and reliance upon Earth observation media to orient their ability to conduct first the Cold War and then the War on Terror. Two technological case studies are provided: 1) an account of the development of the Semi-Automated Ground Environment (SAGE) system developed to automate the surveillance necessary for anti-nuclear bomber defence; and 2) a brief history of drone development from the nineteenth century to the present war on terror. These observational media systems provide evidence of how Kittler's two claims regarding media development merge in the teleology of the digital and the "war answer" in which warfare has come to be autonomously guided by computerized media.*

KEYWORDS *SAGE; Drones; Military technology; Fredrich Kittler*

RÉSUMÉ *Cet article offre un compte-rendu historique de la création de médias d'observation de la planète par l'armée américaine et de la dépendance de celle-ci sur ces médias pendant la Guerre froide et, par la suite, la Guerre contre le terrorisme. Deux études de cas sur la technologie s'ensuivent : 1) la présentation du Système d'infrastructure semi-automatique au sol (SAGE), développé afin d'automatiser la surveillance requise pour se défendre contre des bombardiers munis d'armes nucléaires; et 2) une brève histoire du développement des drones à partir du dix-neuvième siècle jusqu'à la Guerre contre le terrorisme actuelle. Ces systèmes d'observation montrent comment les deux affirmations de Friedrich Kittler sur le développement des médias convergent vers une téléologie du numérique et une « réponse guerrière », où la guerre se fait désormais par ordinateur.*

MOTS CLÉS *Système; Drones; Technologie militaire; Fredrich Kittler*

One of the twentieth century's most dubious achievements was its success in repeatedly enacting the old Napoleonic ideal of the "world war," in which all of the globe was imagined as one integrated field of battle. In the past 100 years, this logic has reproduced itself at four primary moments. In the first two, the First and Second

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World Wars, we see numerous state actors forming alliances led by colonial-industrial powers. In the third, the Cold War, we see two "superpowers" partition the globe. Cold War–era American military and political doctrine imagined the entire globe to be a theatre of war, as is evident in General Douglas MacArthur's declaration that "we defend everyplace" because the struggle against Communism is a "global proposition" (Edwards, 1996, p. 11). During this time, the Earth was envisioned as a place in which two warring factions strategically operated to increase their territorial holdings while looking to avoid global thermonuclear war.

In the fourth and current era, the age of the drone, Empire has established the entire globe as a stage on which it enacts a permanent state of exception, claiming universal jurisdiction to track and eliminate the terrorist threat. Now we have shifted from territorial monitoring to global terrorist threat assessment, which calls for precision strikes and more fine-grained, local, and immediate enemy detection. This has helped establish the world as an emergent theatre of war that is addressable only through the deterritorializing logics of the Earth-observing drone: as numerous incidents since 2010 have indicated, not only are American drones being deployed to the far reaches of North Africa and the Middle East, but they are also becoming an increasingly prominent policing technology of U.S. domestic security forces.[1]

This article argues that these evolving logics of enemy detection, recognition, and response are bound up with media-specific modes of observing and knowing. We analyze two military media forms, the Semi-Automated Ground Environment (SAGE) and unmanned aerial vehicles (UAVs, or drones), as a means for understanding the centrality of technological automation to Earth observation and the changing forms of media-military capabilities for response. We thus tell two different yet overlapping stories. The first is devoted to the development of SAGE, the first continentally comprehensive computerized and automated enemy detection system, created during the 1950s by the U.S. military to detect long-range Soviet atomic bombers. The second traces the fits and starts in the development of what are now called drones. While ethical, moral, and geopolitical concerns most readily orient discussions of drones, in particular as their use relates to "just war" (Asaro, 2008; Reeves & May, in press), our concern is with the increasing autonomy of drones' attack mechanisms.

SAGE allows us to formulate a theoretical model for understanding the automation of perceptual, mnemonic, and epistemological labour at the behest of military intelligence; and with drones, we are interested in how these forms of labour are becoming integrated with autonomous attack protocols, or terminal labour. Ultimately, these case studies allow us to make a number of related observations about media evolution, anthropophobia, and the automation of labour. First, we will suggest that SAGE and drones are manifestations of two of Friedrich Kittler's theses on media technologies: "the war answer" (Winthrop-Young, 2011) and media's digital teleology (Peters, 2010). As media development is often driven by the military's fundamental communicative desire—because, in Kittler's (1997) words, "[c]ommand in war has to be digital precisely because war itself is noisy" (p. 119)—whole-Earth observation has roots in a militaristic enterprise that is media-dependent. In addition, the drive to digitize this capability inevitably leads to the automation of observation via digital collection, storage, transmission, and processing media. The automation of these capacities, we argue, is traceable to a logic of anthropophobia that calls into question Marshall McLuhan's (1964) classic thesis that media are "extensions of man." Responding to this "anthropocentric illusion" (Gane, 2006, p. 39), Kittler (1997) argues, "[t]echnical media don't arise out of human needs, as their current interpretation in terms of bodily prostheses has it, they follow each other in a rhythm of escalating strategic answers" (p. 121). As we will illustrate, oftentimes these strategic technical developments are answers to the human problem, as humans are recognized to have emotional and physical vulnerabilities to which machines are not susceptible. The drive toward automation and digitization thus fuels this anthropophobia, particularly in the development of military-based Earth-observation media.

We suggest that these tendencies point toward the computer automation of our most fundamental political practice, the determination of friend from enemy.[2] Over the past 70 years, numerous media have been used to accomplish and automate this process, which in military terms is called Identification Friend or Foe and is an entire subfield of military communications.[3] The world as a military phenomenon has been a space for media-enhanced and automated knowledge production and binary enemy identification since SAGE; now, with Empire's universal jurisdiction and lack of juridical accountability, the U.S. military and allied institutions have begun to transform what was primarily an epistemological project during SAGE into a single sense/attack process, automating the traditional military logics of identify/kill. Describing how the invention of the global battlefield has been combined with this logic of termination, Peter Sloderdijk (2009) has written:

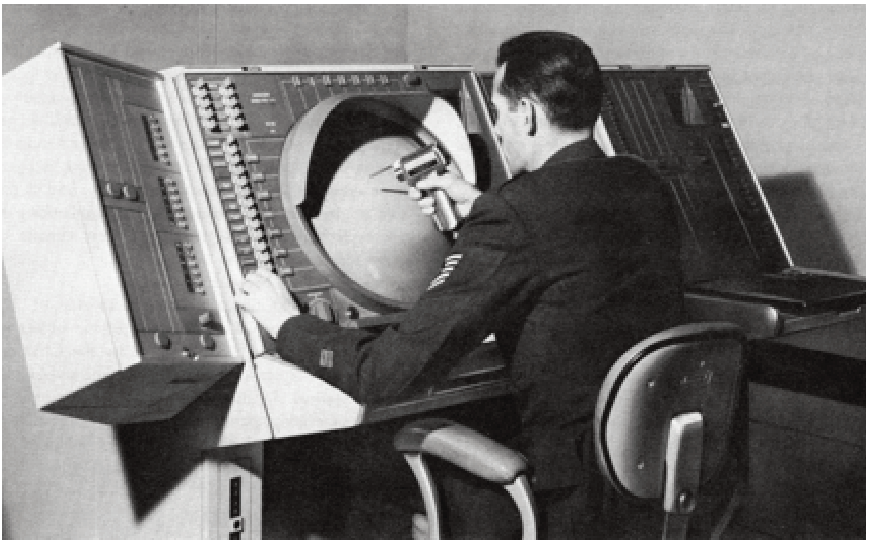
> By means of this expansion in combat zones, the principle of explication emerged in the art of warfare: the enemy became an object in the environment whose removal was vital to the system's survival. [This] is the maximal explication of the other from the point of view of his exterminability. (p. 28)

With the rise of the drone, Earth observation media are no longer needed in order to simply watch and deter the enemy; rather, they are now being integrated with automated attack capacities so that they can most efficiently track and eliminate the enemy no matter where it might hide. This has led to a reckless reconstitution of the world as war-space, as the enemies and potential enemies of Empire are watched 24 hours a day from the skies above places like Yemen and Pakistan, where Earth observation threatens to turn into "fire and forget" at any moment.[4]

The foundations of SAGE

The decade following the Soviet Union's first successful atomic explosion in 1949 witnessed not only the development of ever more sophisticated and powerful weapons of mass destruction but also the creation of a vast automated surveillance system that screened the skies for signs of Soviet bombers. SAGE, or the Semi-Automatic Ground Environment, was the largest information, communications, command, and control system created up to that point. Its explicit purpose was twofold: 1) the interception of incoming bombers to stave off the destruction of targets in the U.S. and Canada, and 2) ensuring that a counter-strike upon the Soviet Union could be carried out. SAGE was composed of a network of 26 control centres spread along the U.S. coasts and Canada, each of which housed a pair of the IBM AN/FSQ7. At 200,000 square feet each, they were the largest computers ever built and easily the most powerful of their day. These colossal concrete centres collected, shared, and processed the data generated by dozens of radar stations, up-to-the-minute air-traffic reports throughout North America, and acted as command centres for the remote guidance of interceptor aircraft. The ability to comprehensively monitor the airspace of the United States, as well as most of Canada, was a monumental intellectual, technical, and organizational task (Dyson, 1997; Edwards, 1996; Hughes, 1998; Noble, 1984; Redmond & Smith, 2000; Schaffel, 2004). Further, SAGE's offspring eventually "formed the core of a worldwide satellite, sensor, and communications web that would allow global oversight and instantaneous military response" (Edwards 1996, p. 75). SAGE was the initial salvo in the U.S. military's campaign to achieve comprehensive global surveillance through automated remote sensing, tracking, and response technologies.

Figure 1: SAGE display scope



Source: www.theatlantic.com/technology/archive/2013/01/

SAGE represented a new means for carrying out the immaterial labour of *perceptual, mnemonic, and epistemological labour,* the work of sensing, remembering, and knowing. It replaced several hundred thousand civilian volunteers spread across the United States and Canada. Further, its creators used SAGE as a means to experiment with automating human intellect, producing what is commonly thought of as artificial intelligence. In simple terms, as in so many other arenas, SAGE used technology to automate work that had previously been accomplished by humans. Yet the kind of labour it automated differed greatly from that of industrial production—SAGE automated Earth observation. In addition, SAGE is a paradigmatic case for understanding media as *screening technologies* (Packer & Oswald, 2010). Screening technologies are defined by one broad goal and are increasingly oriented around digital display screens (see Figure 1). The broad goal of screening is abstract, yet manifests in such simple devices as mosquito netting and colanders, as well as such complex hypothetical technologies as the Strategic Defense Initiative, better known as the "Star Wars" program. These are technologies that work to separate desirable from undesirable elements, determining what can and should enter or leave. This labour is automated by the SAGE system in at least three ways: 1) It works to sort the acceptable from the unacceptable even as it 2) is predetermined by a specific problematization or expectation of what forms of movement and activity are deemed dangerous or beneficial and 3) is assumed to learn from past events to act on the world in increasingly sophisticated and faster ways.

SAGE developed out of an anthropophobic rationality: namely, the belief that military observation and response mechanisms must eliminate the possibility for human error. It is widely acknowledged that the failure to successfully recognize and respond to the Japanese attack on Pearl Harbor in December of 1941 drove home the necessity for proper air surveillance accompanied by a clear set of communication and response protocols. Although the planes comprising the Japanese attack were seen on radar, they were not verified as being Japanese planes but were assumed to be American (Kahn, 1967). In semiotic terms, the sign was present, but was not made to properly signify. The possibility for "mutually assured destruction" (MAD) raised the stakes to such a degree that there was no longer any room for such semiotic failure. Humans must not be allowed to misinterpret the signs of an enemy attack.

In 1952 one such semiotic failure had nearly set off a retaliatory attack. Four commercial aircraft were misidentified as Russian bombers, and for the first time ever the U.S. military's Air Defense Readiness alert was called, necessitating that all defensive and retaliatory measures were ordered to prepare for war. Robert Buderi (1996) in his history of radar explains:

> Officials had no idea whether the sightings were real, or if other planes were also approaching the country's borders. In the end, commercial air traffic had triggered a nuclear alert, and from that stage it had taken anywhere from thirteen to thirty-nine minutes for the ADC to notify cooperating commands over commercial telephone lines, a potentially tragic delay. (p. 381)

According to Air Force Chief of Staff Hoyt Vandenburg, this event made evident " 'the very thin margin of evidence' on which the nation's survival depended" (Buderi, 1996, p. 381). Overcoming the possibility for such errors was already a central concern of the military's Air Defense Systems Engineering Committee, commissioned in 1949 to assess the capabilities of the then-current system to stave off a Soviet atomic bombing attack. According to Morton Astrahan and John Jacobs, two of the central figures in the development of the SAGE system, the commission believed the system "had very low capability" and "suggested that a longer range look be taken at the problem. It recommended the extensive use of automation, particularly computers to handle the bookkeeping, surveillance, and control problems in the implementation of the next generation of air-defense systems" (Astrahan & Jacobs, 1983, p. 341). SAGE would become the system that computerized and automated military Earth observation.

SAGE and the automation of perceptual, mnemonic, and epistemological labour

America is now armed with instant electronic reflexes.

—*Where America's Peace of Mind Begins,* IBM promotional film, 1960

According to a series of IBM-funded promotional movies and television commercials, SAGE provided the body of the nation its own "extensions of man" that vigilantly watched the skies, ever prepared to beat back enemy threats. This electronic screen was presented as a capable, provident, and necessary technology for keeping Americans safe. One of the more telling features of this promotional campaign is the way in which it invokes human bodily and cognitive metaphors to explain SAGE's prowess. The automation and computerization of surveillance replaces sensory and cognitive labour previously accomplished by humans. This labour of surveillance and observation can be broken down into three components: collect, store, and process data. These three coincide with German media theorist Friedrich Kittler's (1999) fundamental elements of media as outlined in *Gramophone, Film, Typewriter*. This is to suggest that surveillance is fundamentally a process of mediation. While Kittler would have a problem with IBM's anthropocentrism and their use of McLuhanesque (1964) terminology (see Winthrop-Young, 2011), it was certainly the case that earlier forms of surveillance and media depended upon human sight and hearing to collect information, human memory or logs to store what was seen or heard, and human intellect to give meaning to or process what was collected and stored—what we have characterized as perceptual, mnemonic, and epistemological labour.

SAGE provided groundbreaking technologies and processes that led the way to automating and replacing all three of these necessary capacities. In particular, SAGE networked a vast number of radar stations, developed groundbreaking means for data storage through core memory technologies, created the first real-time interactive data screens, and experimented with artificial and cyborg intelligence. The centrality of Whirlwind as the backbone of these processes cannot be overstressed. More generally, the creation of the Whirlwind computer as it came to function in SAGE was responsible for a stunning number of advances in computerization that are still fundamental to the basic architecture of present-day computers. In particular, random access memory (RAM) was a direct descendant of the core memory created for Whirlwind, which replaced vacuum tubes and other more obscure forms of storage. The multi-track magnetic drum is a direct precursor to hard drives. The display scope not only provided real-time representation of radar data, but it was also the first interactive screen that allowed for visually inspecting the workings of a computer without having to look at printouts of some sort (Manovich, 2001).

Kittler's (1999) focus upon the ability of electronic media to collect, store, and process data is fundamental for any understanding of automated information collection. As Kittler made clear, one of the fundamental shifts that accompany the advent of film and phonograph is that some elements of the world, from the mid-nineteenth century on, can be captured mechanically without the need of immediate or direct human involvement. Film and the phonograph automate the process of collecting auditory and optical data, while the telegraph and other electronic media add the ability to save and transfer that data through time and space. Considering SAGE within the trajectory of what Kittler (2010) calls "optical media" makes clear that it is a medium used to perceive objects in space and, crucially, more readily analyze such information by creating a databank that can be used to re-create or preserve recorded events. As Kittler following from Paul Virilio (1989) has explained, optical media have been used to solve such problems as the aiming of ballistics as early as the sixteenth century (Kittler, 2010). Put simply, optical media have from their inception been used to visualize the field of battle and hone the accuracy of ballistics.

Radar and sonar use radio and sound waves to more accurately collect such spatial data. These data were digitized and represented on radar screens, the precursor to first the computer screen and more generally to contemporary interactive LCD screens. The SAGE display scope allowed users to directly interact with the screen itself through a simple tool that could be pointed at the screen. Once media and computers are combined to digitize these data, the control-oriented telos of computerization reaches its logical conclusion. Kittler (1999) suggests that the "[l]anguage of the upper echelons of leadership is always digital" (p. 249). It started with notion that God divided time into day and night, on or off. As Kittler and others have explained, digital computing was generated out of the need in the Second World War to guide or intercept projectiles and to encrypt and decrypt messages. Command structures demand clarity *and* secrecy. They engage in the control of both the material and the immaterial; missiles need intercepting, commands need intercepting. The language of control and command needs to diminish or cipher away noise in order to create definitive yeses and nos. As previously noted, "Command in war has to be digital precisely because war itself is noisy" (Kittler, 1997, p. 119). The most efficient means for creating such control is to reduce the state of all things such that they correspond to ones or zeroes. This is one element of the epistemology of the digital that overlaps with processes of normalization. Clear distinctions must exist between the normal and the abnormal: distinguishing the "yes, you are" from the "no, you are not"; 1 and 0; presence and absence. The most fundamental of these determinations is recognition of friend or foe. As one of us has suggested previously, this sort of binary epistemology runs the risk of turning everyone into a potential enemy (Packer, 2006) or creating scenarios in which the necessity for determining what characteristics are representative of friends automatically produces enemies (Packer, 2007). Yet it is the dominant epistemological condition of algorithms currently in use by the U.S. military. The ultimate logic of such an epistemology would treat amalgamations of data (whether associated with a specific human, a human machine assemblage, or multiple such assemblages) across the planet on a set-by-set, moment-to-moment basis to determine whether the threshold dividing friend from enemy has been crossed. It is not a question of locating ontologically given enemies, but rather producing enemies according to algorithmic determination.

At the time of SAGE's development, game theory was being advanced by van Neumann and its application to describe and make sense of the world was gaining momentum just as more and more war games were being played by RAND and others

(Dyson, 1997). The dominant logics to emerge in the post-war world were communications-based cybernetics, game theory, and military operations research, which Jordan Crandall (2005) suggests produced "operational media"—media that are a part of the "machine-aided process of disciplinary attentiveness, embodied in practice, that is bound up within the demands of a new production and security regime" (n.p.). SAGE is one such operational media apparatus whose surveillance capabilities are useful insofar as they answer to the particular problematic in which "games of truth" are played out (Foucault, 1985). Cold War operations research is the ultimate board game for such truths to develop. These games determined what was "in the true" by running as many simulations as possible to determine the likelihood, or relative truthfulness, of any given form of attack. The results of such games would determine how surveillance was conducted and how surveillance apparatuses were constructed and upon what they were aimed. Such strong faith in systems theory and game theory legitimated experiments in artificial intelligence that emerged alongside SAGE and which push even further the limits of replacing human epistemological labour with computer automation.

Even if you know where to look and what to look for, there is still the necessity of determining how to recognize what you are seeing. Whether this is a blip on a radar screen or a distant speck in the sky, tools of recognition and protocols for tracking—that is, maintaining surveillance—also needed to be developed. Given an acceptable and executable set of surveillance protocols, norms must be created that determine and highlight the distinguishing characteristics of what is being examined within a given field. The establishment of norms and abnormalities is foundational to surveillance. Such norms are largely determined by what imagined problem surveillance solves. Such problems may be illegalities (as with speed limit enforcement), perceptual insufficiencies (as with looking into the body via MRI technologies), or the potential destruction of all human life on the planet (as with our present example or scouring the galaxy for meteors on a collision course with the Earth). Michel Foucault's term for such an approach to historical investigation is problematization (Foucault, 1996). As Robert R. Everett, computer scientist, Department of Defense winner of a Medal for Distinguished Public Service, and SAGE veteran, succinctly put it, "We invented all kinds of things, not because we were so smart, but because we were the first people who had the problem" (see Buderi, 1996, n.p.). We suggest that the importance of this particular problematization—failure to detect = utter annihilation—creates the conditions for which total and complete knowledge and control are deemed necessary. A daunting problem demanded an extreme solution. This solution essentially suggested that since human perception and decision-making are fallible as well as limited in speed and scope, perceptual, mnemonic, and epistemological labour must be turned over to machines. Machines must do the work of saving humanity from itself by observing all nuclear threats.

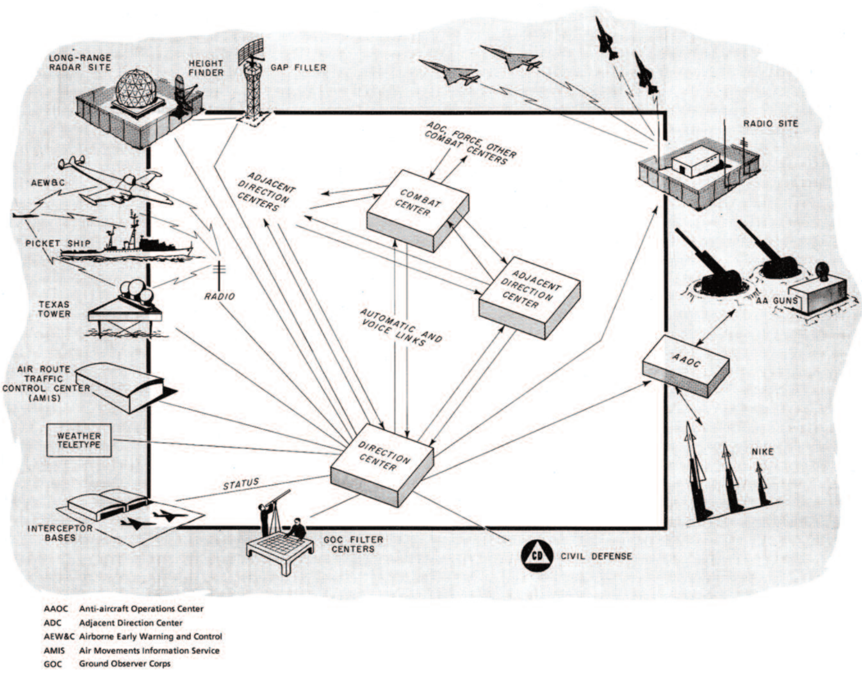
If we bring several of these threads together, we can clarify the difficulties in making what would seem to be a relatively easy distinction, friend or foe—death-dealing Russian bomber or commerce-carrying cargo plane. For SAGE, the first order of business was to locate and track all airborne vehicles. Once detected, the second order of business was to determine whether any given radar blip posed a threat. Yet radar merely acknowledges presence or absence. Presence is of course configured here as something distinct from the particular medium through which sound waves or radio waves can flow relatively unhindered. In other words, absence does not truly mean nothing is there, but rather, nothing that will reflect waves back to a receiver is present. Thus, the desire to find a specific category of objects (reflective) informs what we might call the radiographic-episteme. This episteme might be summarized as all that can be known through the reflective conditions and characteristics of radio waves and environment. Further, it is through the storage and comparison of each wave of blips that the axis of time is added to the spatial axis. Such processed data still adds only pace to the configuration of presence and absence. How can one reconfigure mere presence into known threat?

The only workable means for distinguishing friend from foe was to have complete knowledge of one's friends and thus by the process of elimination determine who was a foe. In practical terms, this meant creating a real-time database of every known friendly flyer in the entirety of North America. All civilian, commercial, government, and military airborne vehicles (planes, helicopters, missiles, hot air balloons, etc.) had to register each and every flight. This vast database was continually uploaded to the SAGE system using punch cards first developed by IBM to contend with the 1890 census. SAGE input data for all future commercial flights using data punch cards. Some of these necessities and capacities were promoted by IBM in their film *Where America's Peace of Mind Begins* (IBM Corporation, 1960). This virtual supposed-to-be or "the expected picture" is checked against the real-time actual or "the real picture seen by radar" in order to sort the acceptable future from the unacceptable in the present. As the film notes, "If a flying object does not belong" it is called a "blip: unknown flying object." SAGE is then called upon to determine "friend or foe" while a missile is armed and aimed at the potential foe to ensure that this screening technology can work properly to deter improper flows from penetrating U.S. air-space. SAGE then continually tracks the intruder ensuring that "there is no escape" (IBM Corporation, 1960) while simultaneously calculating the point of intercept.

All flight data in the United States and Canada was necessarily processed in order to create a virtual scenario of where every flight *should be*. When a blip did not correspond to this virtuality, it was assumed to represent the presence of a hostile. Hence, aviation was brought under complete surveillance. Not by the SAGE system per se, but by the necessity of radar's incapacity to distinguish between friend and enemy. More so, the necessity for indisputable identification was the axis upon which all of MAD depended. Within MAD's protocol, misidentification necessarily led to nuclear destruction. Such ramifications demanded epistemological certainty, which at least theoretically depended upon the infallible Earth observation.

While many of the breakthroughs in radar were devoted to automating perception, another breakthrough of the SAGE system automated memory. One problem of charting the path of a radar sighting was mapping a set of intermittent blips, separated in time, across a screen whose imagery could not be captured. So while radar provided the first real-time computer visualization technology (Manovich, 2001), real time is fleeting. IBM solved this problem by creating radar screens with memory. These radar screens, or "display scopes" as they were known, invoke the notion of the Greek *skopos*, meaning "to mark to shoot at." However, to successfully aim and fire, the vast amounts of accumulated data had to be readily available. "Every instrument in this room is constantly monitoring, testing, pulse-taking, controlling," according to *On Guard*, another IBM film devoted to SAGE (IBM Corporation, 1956). A cybernetic feedback sensibility undergirds the film as the audience learns how the system tests and checks itself to learn from past events to better react to future threats. Data inputted by three types of radar (search, gap filler, and height finder), "Texas towers" (offshore radar platforms modelled on oil drilling rigs), picket ships, early warning aircraft, the Ground Observer Corps (until 1959), and weather bureaus were added to all of the data concerning commercial flights, military aircraft, anti-aircraft guns, and defensive missiles (see Figure 2). Although magnetic drums and tape were in use for general memory storage, new forms of instantly retrievable memory needed to be created to maintain real-time surveillance and response. For this, a "multiple-track magnetic drum whose rotation rate

Figure 2: The SAGE network



Source: www.mitre.org/about/photo_archives/sage_photo.html

could be synchronized with radar repetition rate" (Harrington, 1983, p. 373) was created by the Burroughs corporation specifically for SAGE. Provided with this new memory, "the scope can recall any previous phase of the situation" (IBM Corporation, 1956). This allowed for the ultimate goal of the system to be achieved. As IBM pronounced, "[B]y analyzing the past SAGE can project into the future" (IBM Corporation, 1956).

Having addressed perceptual and mnemonic automation, this section ends with an analysis of how epistemological labour was transformed by SAGE. The work of producing truth could be seen as moving in two different directions through SAGE. Each of these directions was supported by a different theory of intelligence and computation. On the one hand was the computer as a mathematical logic machine that helped automate specific tasks. The other approach was modeled as a cyborg. Machine and man would reprogram each other. Through the creation of a cybernetic system built on feedback loops, a cybernetic-organism—cyborg—would be created. These two competing visions were given a chance to go head to head in the SAGE system. RAND was commissioned to create an experimental system to supplement or replace SAGE that differed in kind from SAGE's ability to integrate multiple logical systems and operations together through data processing and computation. This new system was dubbed Leviathan and developed not to integrate human systems through computation, but rather to create a "non-computational way" of making decisions that depended upon a self-designing and highly adaptive computer that could self-determine the best means for controlling an air-defence system. SAGE's perceived failure was built into any system that "incorporates symbols" (Dyson, 1997, p. 181) which need to be *interpreted by human agents.* Any such system has an inherent likelihood of failure. Leviathan was then an attempt to alleviate human semiotic fallibility by creating a system independent from human perception or cognition—a system free of human semiosis.

Andrew Pickering (1995) stresses that cyborg science acknowledges the agency of human and non-human actors. The cyborg for him is then a system that works to combine tools, things, people, and processes in order to accomplish quantifiable goals through analysis, experimentation, and development. Pickering terms the analysis of such developments "cyborg history." Drawing upon Foucault, Pickering suggests that the development of Big Science and the U.S. military beginning with World War II leads to a "WWII regime" in which operations research and systems engineering come to dominate not only military strategy, but corporate and governmental rationality as well. Leviathan is a perfect example of how systems engineering moves across different fields of social organization and action. Further, the internal RAND competition points out how two competing models for how cyborgs should be understood were tested in the SAGE program. One understanding suggests that cyborgs augment human capacities, while the other dreamed of a world in which cyborgs could replace humans in various realms of action.

Leviathan was not only meant to automate production or even the production of knowledge, but also to automate the very process of systems engineering. Taken to its logical conclusion, such self-engineered systems would create machines that create machines. Further, the capacity to not only produce things, but to determine why such things should be produced in the first place reorients how we might think about automation when what is being automated is not simply intelligence, but the establishment of goals. The plan for Leviathan was that the immaterial labour necessary to organize, create, and direct the networked technological systems that envelop the globe would no longer be dependent upon human labour, material or immaterial. Its developers even nicknamed the new unit of measurement used to evaluate the amount of "social energy," or intellectual labour performed by Leviathan, as a "taylor" (Dyson, 1997, p. 182), after F.W. Taylor, the progenitor of time-and-motion studies. Taylor was fundamental in recognizing and making use of the productive capacity of surveillance to create labour efficiency and interchangeability (Andrejevic, 2002). Following from Foucault (1975), surveillance is not merely coercive or constraining (e.g., limiting freedom), rather it is productive of new relations of power and the enhancement of myriad capacities. Thus, at its core, Leviathan was envisioned as the ultimate solution to the semiotic failings of humans, whose modes of communication inherently led to systems failure.

Taming the beast: Trials of control in early drone deployment

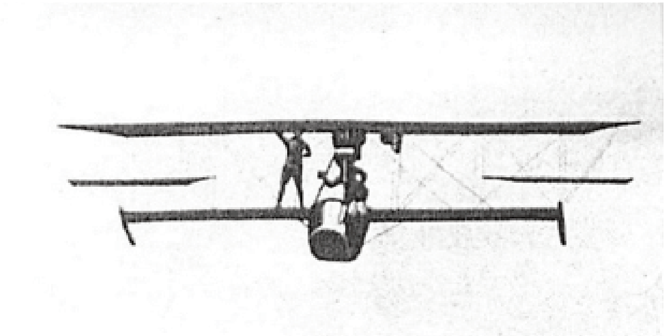
As with SAGE, humans have had an ambivalent history with drones. While a telos of autonomous drone warfare might seem clear today, throughout much of UAV history there has been a struggle to insinuate a virtual human presence into "unmanned" aircraft. Autonomous systems, in fact, were recognized to generate a great number of liabilities. A good place to begin this story is in 1848, when the Austrians were struggling to hold onto their empire amid the nationalist revolutions that were sweeping much of Europe. Facing revolts throughout Italy, the Austrian military command decided to deploy a counteroffensive against the rebels' Venetian stronghold. Yet the Venetian Lagoon, the shallow Adriatic bay that surrounds Venice, prevented the Austrians from deploying a direct infantry attack. So the Austrians resorted to aerial warfare, deploying 200 war balloons, each around 20 feet in diameter, toward the newly declared Venetian Republic. While balloons had been used for military reconnaissance and support since the Napoleonic Wars, the Austrians' balloons were not filled with men and materiel; instead, they were each loaded with 33 pounds of explosives and sent aloft over the enemy lines, where they were then to be detonated over key installations as their half-hour fuses burned out. Thus in the skies above Venice, unmanned aerial warfare was born.

Yet the results were not quite what the Austrians had in mind. While a few of the balloons reached their targets, an uncooperative breeze blew a number of the balloons back over Austrian lines, where they wreaked havoc on Austria's own troops (Mikesh, 1973). After this notorious blunder the Austrians suspended their use of these proto drones, resorting to weapons like rifles and bayonets that remained under the surer control of soldiers in the field. This episode illustrates some of the early problems that faced autonomous war machines. In their earliest days, unmanned military aircraft relied on the weather for navigation and fuses for delayed weapons delivery. Yet World War I provided a new impetus for the development of autonomous aircraft, and the inventions of the airplane and the gyroscope allowed UAVs to attain a certain degree of operational autonomy.

For example, the wooden Kettering "Bug," an American aerial torpedo produced during the First World War, was constructed as an autonomous flying bomb. Stabilized by an aneroid barometer and an on-board gyroscope, this precursor to the cruise missile was launched from a wheeled car; it would then fly for a predetermined number of engine revolutions before shedding its wings and falling from the skies. At this point the Bug hurtled to the ground, where its explosive-rigged 550-pound frame would detonate upon impact (Reilly, 1997). Likewise, the more sophisticated Hewitt-Sperry Automatic

Airplane and the Curtiss-Sperry "Flying Bomb," both of which were aerial torpedoes constructed during World War I by American engineers, used gyrostabilizers to self-regulate and fly at predetermined altitudes and speeds. With their systems of servo-motors, ailerons, and barometers, the Hewitt-Sperry and Curtiss-Sperry crafts were based upon inventor Elmer Sperry's earlier advances in automatic piloting technology and were originally designed as autonomous machines (see Figure 3).[5] Yet because these autonomous craft were beset by numerous premature explosions and other failures, the Navy, which commissioned the project in 1917, decided to advance remote controlling technologies at the expense of autonomous logistics (see Pearson, 1968).

Figure 3: Sperry lifts his hands to show off his new "automatic pilot"



Source: Stoff, 1996, p. 195

This history illustrates how, at this early stage of unmanned systems development, craft autonomy was seen as something to be overcome by the extension of a virtual human presence. The technical inability to assert this remote human control, in fact, severely restricted the domain of aerial warfare. This contributed to a situation in which first-generation drones were deployed to attack territories, not specific infrastructural or human elements within them. As illustrated by the example of the Battle for Venice, *the enemy* was less a group of individuals than an area to be subdued: the early drones' enemy epistemology was tied to a territory rather than to hostile individuals. In other words, simply lofting an explosive-rigged balloon into Venice fuelled an indiscriminate military strategy that did not require a close delineation of hostile and civilian elements within an enemy territory. Yet with the rise of the airplane and its capacity for more precise weapons delivery, it was imagined that radio controls could serve a more finely tuned strategy of attack. There was, therefore, a constant drive to develop media to refine these vehicles' mechanisms of precision, which was seen to be a matter of implicating the human as thoroughly as possible into drones' operations.

While unmanned aircraft were recognized to have several advantages—in particular, greater weapons mobility and decreased personnel exposure—there was a complementary desire for control-at-a-distance. Thus a distrust of the machine was coupled with an instrumental logic that strove to subject the drones' destructive potential to tight human controls. This rationality is particularly visible in drone inventors like Sperry, who referred to the airplane as "a beast of burden obsessed with motion" (see

Mindell, 1996, p. 206). Comparing aerial machinery to a wild animal that must be domesticated by constant human oversight, Sperry sheds light into the techno-ambivalence that fuelled the development of early remote control systems. Describing this ambivalent rationality that Sperry shared with many of his contemporaries, David A. Mindell (1996) writes,

> Like beasts, machinery threatens to run out of control: airplanes spin, ships veer, guns misfire, and systems oscillate. These wild behaviors all enact versions of 'instability,' the precise engineering term for technical chaos. Control systems, like stirrups on a horse, do not create autonomy in the machine but rather harness it, bringing its independence and wildness under the will of human intention. (p. 204)

This logic of domestication fuelled an evolving tension between drone autonomy and human control, as epistemological and ballistic precision were seen to be achievable by various anthropocentric configurations of man and machine (see, e.g., Figure 4; also see Crandall, 2011).

Figure 4: Pilot-bomber, World War I

Source: Stoff, 1996, p. 207

Remote vision technologies, however, would give drones a significantly longer leash by removing their human collaborators from the battlefield and placing them in front of a screen. In 1936, Admiral Delmar Fahrney and the Naval Research Laboratory were commissioned to develop drones that could record and transmit video to remote human crews. Fahrney devised this system of remote control by recruiting RCA to produce a television recorder, what chief RCA engineer Vladimir Zworykin called an "electric eye" for unmanned aircraft. After first developing a 340-pound prototype of the new television system, Zworykin eventually produced a 97-pound box outfitted with a camera and a transmitter. With its battery, antenna, dynamotor, and green picture tube, the battle-ready version of the "Block" was 8 x 8 x 27 inches (Spark, 2005). The Block made possible new games of war, as the screen increasingly becomes the primary point of contact between military personnel and the scene of aerial combat. This militarization of Earth observation, developed under the auspices of "Project Option," became an important element of the Allies' aerial war effort during the Second World War.

While primitive radio-controlled craft could not transmit video back to their remote pilots, the development of remote vision capabilities turned the drone into a perceptual/epistemological as well as a ballistic weapon. Whereas Napoleon had put soldiers into balloons to enhance his vision of the battlefield, the Block permitted the transmission of video footage to screens watched by soldiers in nearby shadow craft (Spark, 2005). These soldiers would then use radio control and television screens to navigate the aircraft toward appropriate targets before releasing bombs, many of which would be remotely guided by humans stationed far away from the scene of impact.[6] With World War II era aircraft like the American Radioplane OQ-series, the British B-24 bomber, the Soviet GIRD-06, and the German V-1, we see the rise of a refined cyborgic configuration that allows enemies to be more precisely isolated and neutralized from a distance, giving rise to a growing refinement in the targeting of specific elements—both infrastructural and human—within a given territory. As drones become equipped to carry out their own perceptual labour, and as this perception is integrated with ballistic capacities, the anthropocentric logic of domestication that had characterized pre-war drone developments begins to give way to a logic of anthropophobia.

Taking people out: Anthropophobia in drone warfare

In the post-war period, research and development of unmanned systems mainly shifted to rocket technologies and intercontinental ballistic missiles. And because the Cold War was in large part a war of surveillance, SAGE and other computing systems took priority over the development of autonomous aircraft.[7] Yet the U.S. continued to develop certain drone programs during the Cold War, and UAVs were deployed in reconnaissance missions throughout the war in Vietnam. Only in the past 10 years, however, have drones become central to global military strategy. In particular, the U.S. is deploying hundreds of drones in places like Afghanistan and Iraq, where there is an official military presence; yet the total extent of their deployment is unknown, because the CIA and the Joint Special Operations Command (JSOC) maintain extensive classified drone programs. While the military conducts thousands of documented UAV missions per year, under the guise of universal jurisdiction the CIA and JSOC have carried out an unknown number of strikes in places like Somalia, Yemen, the Philippines, Uganda, and especially Pakistan (Mazzetti, 2012). UAVs like General Atomics' Predator and Reaper Drones have been deployed in hundreds of lethal missions since the Bosnian War (Arkin, 2009), and their popularity is set to rise: it is estimated that by 2022, 85% of all U.S. Air Force pilots will be operating drones instead of manned aircraft (Bowman, 2012). Today, the Air Force is training more drone pilots than fighter and bomber pilots combined (Bumiller, 2012).

As unmanned aircraft have taken centre stage in U.S. military strategy, the logic of domestication that once drove the advancement of drone technologies is rapidly receding. The human is no longer seen as an ideal instrument of control over robotic beasts of burden, but instead becomes seen as a vulnerable, unreliable cog in an otherwise flawless complex of machinery. For example, despite advances in remote vision capabilities, the transmission of video data from drone aircraft is not instantaneous or easily decipherable: when recording and sending video from Pakistan to American drone "pilots" in New Mexico or Arizona (see Figure 5), there is a pronounced temporal delay in satellite transmission that the industry calls "latency." Targets of Empire have learned to capitalize on this latency, which makes it very difficult for remote pilots to hone in on a moving target. It is well known among target groups that the best de-

Figure 5: An American drone pilot sits before a wall of screens

Source: Bumiller, 2012. Photo by Heather Ainsworth

fence against drone attacks is to run around haphazardly (Mazzetti, 2012). To keep humans in the "kill chain" (United States, Department of Defense, 2009, p. 30; also see United States, Department of Defense, 2011, p. 74) requires the development of a very complex cyborgic system, in which technologies of perception and transmission have to be integrated with remote control mechanisms. In the words of Kittler (1997), these fecund technical developments tend to "follow each other in a rhythm of escalating strategic answers" (p. 121). Many of these strategic answers, of course, are attempts to minimize the human problem, which is constantly causing delays and making costly misjudgments.

Given these complexities, latency is not the only problem facing remotely piloted drones. Not only does human input require an elaborate and inefficient feedback system, but the human *qua* human is seen to be a flawed technology of war. As a being with emotional and biological vulnerabilities, the human is an unfit soldier of the twenty-first century. As Gordon Johnson of the U.S. Joint Forces Command puts it, "[Drones] don't get hungry. They're not afraid. They don't forget their orders. They don't care if the guy next to them has just been shot. Will they do a better job than humans? Yes" (quoted in Arkin. 2009, p. 7). This sensibility is clear in the military's response to failed drone strikes, which are explained away in the language of human error rather than machine malfunction. For example, when a drone strike killed two American servicemen in April 2011, an army report concluded that the deaths should be attributed to "a rush to judgment" and that the two responsible sergeants were guilty of "sending inaccurate radio reports that misled the lieutenant about their locations and calling in the wrong location" (*Daily Mail* reporter, 2011). In the end, the Army chalked up the soldiers' deaths to simple "miscommunications."

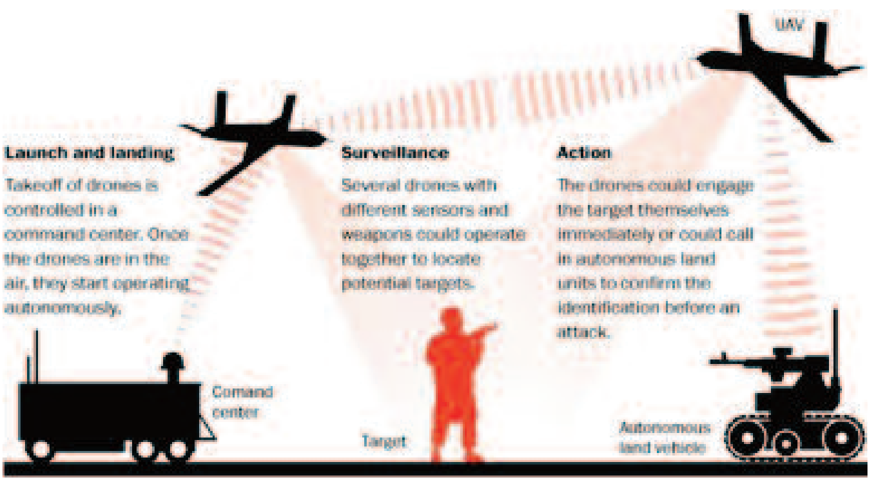
This anthropophobic logic is leading to the development of UAVs that require less and less human oversight. As the United States' conventional military operations wind down in Afghanistan and Iraq, the Department of Defense has requested that previously allotted military intelligence funds be rechannelled to the research and development of autonomous drone aircraft like the one in Figure 6. This shift in funds will provide Chicago-based Boeing Company with more than $600 million to help expand autonomous UAV missions into areas like Somalia and Yemen, where there is already extensive American drone activity. Boeing's crowning vehicle, the ScanEagle, carries either an inertially stabilized electro-optical or an infrared camera that records and transmits real-time data (Cappacio, 2012). While in the past this intelligence was primarily valuable to human ground crews who could refine flights' preprogrammed coordinates, the transmission and autonomous interpretation of data have become essential to the very functioning of the newest generation of drone aircraft. While for the foreseeable future the ScanEagle will still transmit data to human personnel, its most cutting-edge models are being designed to operate in autonomous swarms.[8] In June 2011, two ScanEagles and the Procerus Unicorn, a drone developed by the Johns Hopkins University Applied Physics Laboratory, performed a fully autonomous joint mission using swarm technology (Mortimer, 2011). The success of these and similar missions suggests that the long evolution toward robotic autonomy is now being fulfilled in the emergence of integrated swarms of armed drones. As robotics expert Peter Singer observes, "We're moving into more and more autonomous systems. That's an evolutionary arc.… So the role moves from being sort of the operator from afar, to more like the supervisor or manager, and a manager giving more and more of a leash, more and more independence" (De Luce, 2012, n.p.). As twenty-first-century warfare relies more and more on autonomous weapons and reconnaissance systems, human

Figure 6: A Predator drone firing a Hellfire missile

Source: Homeland Security News Wire, 2011 soldiers will be placed in an ambivalent position vis-à-vis robots: an increasing number of soldiers will assume roles that are simultaneously supervisory and subordinate to machines, as they find themselves supporting drones that have been programmed to wage war via networked swarm intelligence (Cole, 2012). According to Air Force General Norton Schwartz, "For the next maybe 30 years, in my view, there will continue to be a mix between manned tactical aviation and remotely piloted aircraft" (Bowman, 2012). For Schwarz and other top military brass, the question is not *if* lethal air missions will eventually become completely unmanned, but rather the extent to which the human will be allowed to operate alongside the lethal machine.

In 2011, journalist Peter Finn was invited to observe a test swarm mission at Fort Benning in Georgia. There he saw two model-size autonomous drones rise to altitudes of about 1,000 feet, scouring the grounds for a predetermined target: a large, colourful tarp hidden on a far side of the base. One of the drones, which was outfitted with an on-board camera to capture video and a computer to analyze that data, soon located the tarp. It then autonomously transmitted a message to its partner craft, which approached the tarp and confirmed its coordinates. The second drone then sent its own message to an unmanned ground vehicle, which autonomously sped through the terrain to the mission's target. Finn remarked, "This successful exercise in autonomous robotics could presage the future of the American way of war: a day when drones hunt, identify and kill the enemy based on calculations made by software, not decisions made by humans" (Finn, 2011). The trend identified by Finn is obvious in the research and development of network-centric autonomous warfare, as advances in system dy-

Figure 7: Illustration of a lethal swarm mission



Source: Finn, 2011. Graphic by Alberto Cuadra and Peter Finn.

namics are endowing drones with the capacity to observe, capture, and transmit data to surrounding craft, which, as Figure 7 demonstrates, collaboratively identify targets and carry out missions based on heuristic algorithms (Basso, Love, & Hedrick, 2011). In military parlance, these stages of swarm warfare constitute the "kill chain" of twenty-first-century autonomous missions: Find, Fix, Track, Target, Engage, Assess (United States, Department of Defense, 2009, p. 30). Capitalizing on the mnemonic labour carried out by previous missions, the networked intelligence on which the kill chain depends grows more precise with every deployment (United States, Department of Defense, 2009).

Conclusion: Drone on

The dream of the perfectly efficient war machine—which will not be beset by "miscommunications" or moral hesitation, and which will work without a salary—will continue to dominate the imagination of military bureaucracies and contractors. But despite the fact that UAVs are sometimes accurate enough to neutralize their targets hiding in the remote mountains of Yemen or Pakistan, the current policy of dehumanizing warfare is of a piece with unmanned systems' historical catalogue of misfires, failures, and indiscriminate fatalities. While roboticists like Ronald Arkin (2009) dream of drone fleets that act as "humane-oids" (p. xvi)—i.e., UAVs with an "artificial conscience" that will make them more ethical in combat than human soldiers—thus far drones have given rise to a style of total war that is anything but accurate or ethical (Gregory, 2011). To take merely one example, in 2009 a drone strike in southern Waziristan killed Baitullah Mehsud, the head of the Pakistani Taliban. Yet this strike, which also incinerated his wife, was the CIA's fifth drone assassination attempt on Mehsud. One of the earlier strikes killed 35 people, including at least eight civilians and an eight-year-old boy. And Mehsud had previously escaped another failed attack in which 45 civilians were killed (International Human Rights and Conflict Resolution Clinic & Global Justice Clinic, 2012). This tragic story, unfortunately, is only one account of how drone strikes—bolstered by a War on Terror rationality, in which terrorists can be hunted down anywhere and taken out with unlimited collateral damage—have left thousands of innocent civilians dead in their wake. Of the estimated 2,500 people killed by U.S. drone strikes since 2009, about 49, or 2%, have been designated "militant leaders" (p. vii). The rest have been low-level fighters, innocent bystanders, and children. Part of this casualty toll can be attributed to the inaccuracy and extensive reach of drone artillery, as shrapnel often scatters 20 feet around an attack site. More still is traceable to the nonchalance with which the CIA deploys faulty epistemological and ballistic systems, such as the notoriously inaccurate "Geospatial" software that produced weapons delivery coordinates that were as much as 13 metres off target (Stein, 2010). The epistemological care that characterized the SAGE project has been abandoned, as the promise of mutually assured destruction has been replaced by the unaccountability and hubris of Empire. Needless to say, these are problems that robots cannot solve.

The digital automation of perceptual, mnemonic, epistemological, and, finally, terminal labour by Earth-observing media has largely been driven by military anthropophobia. As Kittler clearly articulated, communication in war needs to be digital to wipe out the uncertainty created by human fallibility. Human observation, memory, thought, semiotic capacity, and moral ambiguity add too much noise into the chain of military command and control. Yet the effects of miscommunication and epistemological failure in the era of SAGE potentially led to thermonuclear global annihilation. Earth observation called for digital automation, but humans were still asked to push the button. Epistemological failure in the age of the drone has led not to nuclear escalation, but rather to human semiotic creativity. Following drone-induced wide-scale collateral damage, enemies were distinguished from friends, *ex post facto,* by rhetorical fiat, not by validated evidence. As Jo Becker and Scott Shane (2012) of the *New York Times* clarified, "Mr. Obama embraced a disputed method for counting civilian casualties that did little to box him in. It in effect counts all military-age males in a strike zone as combatants" (n.p.). The epistemology of the digital only guarantees that the world will be processed through unmistakable binary digits; it doesn't guarantee fidelity between signifier and signified. In the War on Terror, enemies will always be located; regardless of how many *ones* are eliminated, there will never be *zero* terrorists (see Horn, 2003). In the last instance, the state of exception validates sovereign semiosis. The lack of reciprocity for non-state actors to partake in the human semiotic chain allows for the unchecked and wider experimentation with the weaponization of Earth-observing media. The War on Terror has no media-induced stalemate, only media escalation.

Notes

1. While officials have not admitted that drones were deployed to hunt notorious ex-cop Christopher Dorner—who committed several homicides in California before fleeing into the San Bernardino mountains—the U.K. newspaper *The Express* reports that a "senior police source" admitted that drones aided in the manhunt (Parker, 2013). Whether or not drones were deployed in this high-profile case, they have been used in a number of U.S. police deployments, including the 2011 arrest of three North Dakota militia members (Bennett, 2011) and an increasing number of farm surveillance cases (see Nelson, 2012).

2. The uptake of Carl Schmitt's (1996) writing on the friend/enemy distinction as the basis of the political has been widely discussed and debated in political theory during recent decades, particularly as it relates to terrorism and the state of exception. We feel no need to directly address such discussions, but rather want to indicate that a clear shift is taking place in which human existentially derived friend or enemy distinctions are being replaced by computer algorithmic determination.

3. One of the first actualizations of this process involved German planes turning over and flying upside down in unison for a short period in order to distinguish themselves from the enemy on the radar screens of German observers, allowing for anti-aircraft guns to aim solely at Allied aircraft.

4. "Fire and Forget" is military shorthand for a weapon with the ability to autonomously hone in on the target after, not prior to, being fired. Hence, humans need not worry about consequences after pulling the trigger.

5. It should be acknowledged that other drones roughly contemporary with the Sperry crafts, such as the British Royal Navy's "Larynx" craft, were also failures and were never deployed on the battlefield (Grove, 2005).

6. Sperry also invented the radio-controlled bomb, which was equipped with an antenna (see Scott, 1920, p. 196).

7. Cruise missiles, which are outfitted with inertial navigation systems that allow environmental feedback to on-board motion sensors—or, on the other hand, with Terrain Contour Matching (TERCOM) that combines cybernetic controls with a pre-set, detailed contour map of the mission's flight and attack terrain—provide the next generation in the development toward twenty-first-century drones, and they now coexist with them as U.S. defence strategy capitalizes on unmanned systems that fire and return (drones) or are themselves the medium of explosives delivery (cruise missiles).

8. This development in swarm technology is not strictly new. Since the Second World War, when radio transmissions risked being picked up by the enemy if transmitted over long distances (Kittler, 1997), networked swarm deployments have provided a means for UAVs to carry out their tasks. For example, a pilot in a nearby shadow plane would fly at a safe distance, directing a UAV that would carry out dangerous missions at lower altitudes (see Yenne, 2004).

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